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ROCKY FLATS
SOLAR POND PROJECTS
ACCELERATED SLUDGE PROCESSING CONCEPTUAL DESIGN

WHITE PAPER
REVISION 1

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EXECUTIVE SUMMARY

Halliburton NUS was contracted by EG&G Rocky Flats to generate a conceptual design to minimally treat sludges from the 207 Solar Evaporation Ponds and Building 788 Clarifier (presently in interim storage tanks) to an acceptable standard (WAC) to allow placement in the Operable Unit 4 closure area.

This White Paper, which is the first deliverable of the conceptual design, includes a Value Engineering Study that evaluated five potential sludge treatment alternatives to identify the treatment system that will satisfy the closure area WAC in the most efficient, reliable, and cost-effective manner, given the operating constraints present at the Rocky Flats Plant. The treatment alternatives evaluated were: Pelletizing, Extrusion, Briquetting, Monolith Casting, and Friable Product. The evaluation utilized the following criteria:

- Effectiveness (will the treated waste product meet the WAC?)
- Implementability (can the treatment system be installed in the space available? What impact does it have on the overall project schedule?)
- Operability (how easy is it to operate and maintain? How reliable is it?)
- Cost (capital, operating and maintenance, decontamination and decommissioning)

The Friable Product Treatment System is recommended as the preferred alternative because it has the least potential impact on the overall project schedule, is the easiest to operate and maintain, offers the greatest operating reliability, and has the lowest total cost.

The preferred treatment system is made up of the following operations:

- Transfer of the sludges from the storage tanks to the treatment mixing/blending process.
- Storage and transfer of additive(s) to the mixing/blending process.
- Mixing/blending the sludge and additive(s) and discharging to a staging area.
- Transfer treated waste to the OU-4 closure area.

The additives used in the treatment process are lime, which is not only a proven biocide, but is also effective in controlling moisture content; cement, for its pozzolanic properties; and a bulking agent, such as sand or

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flyash, to ensure a friable product. The project schedule estimates that the treatment system will be operated for 6 months; an additional 4-month schedule reserve is provided. It is estimated that the treatment system will have the following estimated costs: capital ($2,200,000), operations and maintenance ($2,700,000), and decontamination and dismantling ($170,000).

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1.0 INTRODUCTION

This White Paper, Revision 1, has been generated by Halliburton NUS (HNUS) to satisfy the requirements of the Statement of Work (SOW) entitled "Accelerated Sludge Processing Conceptual Design, Sludge and Pondcrete Processing" (Revision 3), dated October 27, 1994. This SOW replaced the SOW entitled "Accelerated Sludge Processing Conceptual Design" (Revision 1), dated August 3, 1994. As a result, the White Paper generated by HNUS on August 24, 1994, to satisfy the requirements of the August 3rd SOW will now be replaced by this White Paper, Revision 1.

The SOW, Revision 3, specifies that a conceptual design be developed to minimally treat sludges from the five Solar Evaporation Ponds and Building 788 Clarifier, presently stored in tanks on the 750 Pad, to an acceptable standard that will allow placement under the Operable Unit (OU)-4 cap. The SOW stipulated that the conceptual design be developed in two discrete deliverables: a White Paper (Rev. 1) and a Conceptual Design Report (CDR).

This White Paper (Rev. 1), which is the first deliverable, provides a general design and engineering basis for a system that will treat the sludges to the performance standards defined in the Draft Interim Measures/Interim Remedial Action Decision Document for disposal under the OU-4 cap. This White Paper (Rev. 1) also includes a value engineering study that will be used to select a recommended sludge processing system. This White Paper (Rev. 1) will be used to validate and confirm continued design development, and will serve as a basis for the CDR. The information provided in this document is preliminary in nature, pending the results of the pond sludge treatability study.

2.0 BACKGROUND

2.1 HISTORICAL PERSPECTIVE

Operable Unit Four (OU-4), the Solar Ponds, is an element of the United States Department of Energy's (USDOE) Environmental Restoration Program at the Rocky Flats Plant. OU-4 includes five solar evaporation ponds: 207A, 207B series (north, center and south), and 207C. Starting in the late 1950s the ponds were used to store and evaporate low-level radioactive process water.

The sludges have been removed from the five Solar Evaporation Ponds [207A, 207B series (north, center, and south), and 207C] and the Building 788 Clarifier and are being stored on an interim basis in 66 tanks on the 750 Pad. Each of the interim storage tanks has a nominal 10,000-gallon capacity.

Sludges from the Solar Evaporation Ponds 207A and 207B are a combination of liquid and solids, and the total stored volume is approximately 220,000 gallons. Sludges from Solar Evaporation Pond 207C are a combination of liquids, solids, and salts, and the total volume stored is approximately 413,000 gallons. Sludges from the Building 788 Clarifier have a total volume of approximately 27,000 gallons. The hazardous waste codes associated with the wastes from the ponds and clarifier are: F001, F002, F003, F005, F006, F007, F009 and D006.

As part of the closure plans for OU-4, these sludges are to be treated to satisfy specific waste acceptance criteria (WAC) and then placed in the OU-4 closure area and covered with a cap.

2.2 REGULATORY FRAMEWORK

The Rocky Flats Plant has multiple units regulated under the Resource Conservation and Recovery Act of 1976 (RCRA). The Solar Evaporation Ponds (207A, 207B, 207C) are interim status RCRA units. Paragraph 3008(h) of RCRA provides for the issuing of orders requiring corrective action for all releases of hazardous wastes or constituents from solid waste management units at interim status hazardous waste treatment, storage or disposal facilities.

The Rocky Flats Plant is also listed on the National Priorities List (NPL). The NPL is the list of sites that represent a potential threat to human health or the environment which was created and is periodically updated by the United States Environmental Protection Agency (USEPA) pursuant to Section 105 of the

Comprehensive Environmental Response Compensation and Liability Act of 1980 (CERCLA). Section 120 of CERCLA requires remedies for Federal facilities sites on the NPL. Accordingly, the Rocky Flats Plant is subject to regulation under both RCRA and CERCLA.

An Interagency Agreement (IAG), signed by the USDOE, USEPA Region VIII, and the Colorado Department of Public Health and Environment (CDPHE) on January 22, 1991, includes provisions for the remediation of contaminated sites at the Rocky Flats Plant under both RCRA and CERCLA. The IAG identifies sixteen Operable Units (OUs) ranked in order of decreasing risk to human health and the environment. The Solar Evaporation Ponds (207A, 207B, 207C), and Clarifier 788 are part of OU-4, indicating that the closure of these areas is a high priority. These impoundments within OU-4 have been designated as Individual Hazardous Substance Site (IHSS) 101.

The IAG also provides a process for the creation of an Interim Measure/Interim Remedial Action (IM/IRA) Decision Document (DD). An IM/IRA DD for closing the ponds was drafted in May 1994 for review by the regulatory community. The IM/IRA DD serves as the permitting mechanism for the facility. This White Paper (Rev. 1) , and the CDR which is to follow, are to be folded into the IM/IRA DD. Upon finalizing the IM/IRA DD, the USDOE will submit a modification to the Part B Permit Application for Management of Hazardous Wastes that will reflect the contents of the IM/IRA DD.

The IAG requires the closure of OU-4 in two phases: Phase 1, which focuses on source control (characterization, removal and proper disposal of Solar Pond sludges and contaminated soils as well as closure of the Solar Ponds), and Phase 2 which addresses groundwater contamination and other concerns of the regulators. Accordingly, the preparation of this White Paper (Rev. 1) is one of the tasks to be performed within Phase 1.

3.0 DESIGN AND REGULATORY CONSIDERATIONS

3.1 DESIGN CONSIDERATIONS

As a result of the Accelerated Sludge Removal Project (ASRP) initiative conducted during FY 1993 and 1994, sludges were removed from the Solar Evaporation Ponds and Building 788 Clarifier, and placed into interim storage in double-containment storage tanks in Tents 3, 4 and 6 located on 750 Pad. The objective of the current Greatly Accelerated Sludge Processing Project (GASP) initiative is to remove the solar pond sludge from the interim storage tanks and minimally treat these wastes to satisfy the WAC for placement in the OU-4 closure area.

Design and operational considerations for the pond sludge treatment processes are summarized in the following sections.

3.1.1 Waste Acceptance Criteria (WAC)

The revised waste acceptance criteria (WAC), which the treated waste must satisfy before it can be placed in the OU-4 closure area, were presented to HNUS by EG&G Rocky Flats on November 3, 1994. The provisions in the WAC that specifically impact design considerations for the solar pond sludge treatment system include:

- The treated waste shall have no free liquids as verified by the Paint Filter Liquid Test (SW 9095).

- If the treated waste is in a monolithic form, the following apply:

  - each monolith shall not exceed 12 in. x 24 in. x 48 in. in size, and shall not be reinforced.
  - compressive strength shall not exceed 3000 psi; shear and tensile strengths shall not exceed those of 3000 psi strength non-reinforced concrete.
  - non-returnable monolith molds, containers or packaging shall not be used.

- If the treated waste is in particulate form, all particles in the treated waste shall pass through a 3-inch mesh screen, and shall not agglomerate after treatment unless the agglomeration satisfies the requirements specified for monoliths.

- The treated waste shall not cause an exceedence of the particulate or monolith requirements when blended with site soils in the closure area.

- The treated waste shall be resistant to wind dispersion.

- Storage of the treated waste at the OU-4 closure area shall be minimized.

- The treated waste shall not be less protective of human health and the environment than the other materials selected for placement in the closure area.

- Pathogens, if present, shall be rendered innocuous.

- Any gas production from the treated waste shall be no greater than that generated by natural site soil.

3.1.2 Characteristics of Pond Wastes

Ponds 207A, 207B-Series and 788 Clarifier

Based on the nature of their original source materials, the following assumptions are made regarding the sludges from Pond 207A, Pond 207B, and the 788 Clarifier:

- The interim storage tanks are filled with sludge to a depth of 9 to 10 feet. Each tank could contain approximately 9,000 to 10,000 gallons. As a basis for design, a volume of 10,000 gallons per tank has been assumed.

- The sludge, which consists of settled solids and a liquid phase, occupies approximately ninety percent of the tank volume. Some free water was decanted off of the settled sludges in the tanks during storage to reduce the volume in storage.

- The settled sludge, based on previous characterization studies (HNUS Deliverable 224A and 224E, March 1992), are expected to contain approximately 15 percent solids (by weight) and have a high viscosity (500-1000 centipoise).

- The free liquid phase which covers the settled sludge contains some dissolved salts (less than 16,000 mg/l), but has physical properties similar to water.

Pond 207C

The sludge from Pond 207C is different from that stored in the Ponds 207 A and B due to the nature and source of the original wastes deposited for evaporation. Previous sampling and analysis efforts have shown that the waste from Pond 207C consisted of three general layers of material, as follows:

- A liquid phase which was a saturated or near-saturated brine, with sodium and potassium the predominant cations, and nitrate, chloride, and sulfate the predominant anions. Significant concentrations of heavy metals were also present. The brine layer in Pond 207C was stratified with lower Total Dissolved Solids (TDS) and specific gravity values near the pond surface, and higher TDS and specific gravity values at depth. The salinity of the brine layer was also a function of precipitation, evaporation, and temperature. The TDS of the brine layer ranged from 5.8 to 42.9 percent, by weight, based on data collected from the waste characterization study, the treatability study, and a special sampling effort to characterize the degree of stratification of the brine. Specific gravity data ranged from 1.042 to 1.376. Observations from the stabilization treatability study showed that the samples of Pond 207C brine were saturated at approximately 35-40% TDS at room temperature (65-70°F).

- A precipitated/crystallized salt layer between the underlying silt and overlying brine layers. The thickness of this layer varied in response to basic physical and chemical parameters that affect salt crystal solubility, such as temperature and brine salt concentration.

- A solids layer made up of fine-grained material with a biologically degradable organic component as evidenced by gas generation and septic odor. It is estimated that up to 15 percent, by volume, of the pond wastes consisted of this material.

The composition of the Pond 207C material in each storage tank will be a function of the degree of mixing of the brine, crystallized salt, and solids during removal from the pond and placement into the tank. While the contents of each storage tank will no longer be affected by precipitation or evaporation, the amount of salt in solution or in crystalline form could change due to normal temperature fluctuations. The mixture of 207C pond material as placed in the storage tanks is limited to a specific gravity no greater than 1.7 based on an agreement with CDPHE.

3.1.3 Operating Parameters

The daily operating schedule for the sludge treatment facility is a function of:

- the total volume of sludge requiring treatment,
- the available time period for operating (i.e., maximum 130 operating days),
- the requirements of the treatment mix formulation,
- the logistics of materials handling (e.g., pond sludge, treatment additives, and treated waste),
- delays or operating interruptions from outside sources.

Based on the information presented in previous sections regarding the volume and characteristics of the sludges to be treated, it is estimated the following operating rates will be required to satisfy the 130-day operating schedule (see Table 1).

TABLE 1

TREATMENT SYSTEM OPERATING PARAMETERS

	C Pond	A/B Pond	Clarifier	Total
Total Sludge Volume (Gal)	413,000	220,000	27,000	660,000
Total Sludge Volume (CY)	2,045	1,089	134	3,268
Operating Days*	82	43	5	130

*Based on an average daily operating rate of 3268 CY/130 days = 25.14 CY/day

Drawing 1 presents a facilities layout that shows the locations of the treatment system area, pond sludge storage tanks and the OU-4 closure area.

3.2 REGULATORY CONSIDERATIONS

3.2.1 Status of Units of Interest

The Rocky Flats Plant is undergoing a phased program of permitting under RCRA. The facility is applying for permitted status for various hazardous waste units in accordance with prioritization and a schedule negotiated with the CDPHE. Accordingly, Rocky Flats Plant operates under both interim and final (permitted) status. The Solar Evaporation Ponds 207A, 207B, and 207C and the 788 Clarifier form three interim status units (The 788 Clarifier and 207C Pond are each separate units; the 207A and B Ponds are combined to form one unit). Pad 750, which presently supports the tents that house the sludge storage tanks and the proposed sludge treatment equipment, is also an interim status unit. Both units are to be closed under interim status.

3.2.2 Regulatory Compliance Strategy

To facilitate the timely processing and disposal of the treated pond sludge within OU-4, the remedial design proposes to take advantage of modifications to 40 CFR Parts 264 and 265 promulgated by the USEPA on February 16, 1993, and the Colorado analog in 6 CCR 1007-3 promulgated on May 31, 1994. These rules allow for the creation of Corrective Action Management Units (CAMUs) and Temporary Units (TUs). These units "function solely to manage wastes that are generated at a RCRA facility for the purpose of implementing remedial actions required at that facility"... (FR Vol. 58, No. 29, p. 8659). Among other provisions, the rulemaking allows remediation wastes to be consolidated or processed on site without triggering Land Disposal Restrictions (LDRs) or Minimum Technology Requirements (MTRs) which were promulgated to control hazardous waste production from ongoing manufacturing activities. The requirements for the application of CAMUs and TUs are presented in 40 CFR 264 Subpart S, which addresses RCRA-permitted facilities. These requirements are incorporated by reference in 40 CFR 265.1(b) which addresses interim status facilities and which applies to the closure of the Solar Ponds. Colorado's rules substantively incorporate the intent and scope of the Federal rules with certain modifications which address the harmonizing of the CAMU and TU requirements with Colorado's existing hazardous waste rules, and which clarify ambiguities in the Federal rules.

Therefore, the following regulatory assumptions are made for design purposes:

- Equipment used at the excavation site (i.e., earth moving equipment) is considered to be related to the closure of this unit. Such equipment will be the responsibility of the excavation contractor. This includes the materials handling and truck/container loading equipment that will be required as part of this design.

- The treatment equipment to be located in Tent 12 on 750 Pad will be a TU. (It is assumed that a CDPHE permit will be issued for this TU).

- The Solar Ponds will form a CAMU and will serve as the disposal site for the sludges which have been removed from the ponds and are in storage on 750 Pad, as well as the disposal site for contaminated soils from an adjacent area located outside the boundaries proposed for the CAMU.

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In general, hazardous waste treatment units require secondary containment, with exemptions applied to certain types of facilities. The TU rule does not specifically address secondary containment requirements, leaving the determination of the applicable standards to Colorado. It is possible that the treatment system would be entitled to the exemptions provided in the regulations, even if there was no latitude provided in the application of standards. However, for purposes of this design, the following assumptions are made:

- The processing equipment will be provided with secondary containment.

- The sludge feed equipment will be emptied prior to weekends, holidays, or extended downtime. Sludge will be processed until none remains, or leftover sludge will be returned to the interim storage tanks from which it was collected.

- Secondary containment provisions will not be applied to treatment additive(s) since these materials are relatively immobile, and will be carefully contained. Similarly, secondary containment provisions will not be applied to the treated waste.

3.2.3 Other Compliance Requirements

Certain emissions and exposure restrictions apply to USDOE facilities which engage in the management of materials containing radionuclides. With respect to emissions, the National Emissions Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities apply (40 CFR 61.96). These standards specify limits for radionuclide levels in ambient air. In view of the low level of radioactivity associated with the sludges, an emissions impact and/or a significant air permitting effort are not anticipated to be necessary for this design. This matter will be reviewed with the Rocky Flats Plant air quality specialists during the preparation of the CDR and air permitting or monitoring requirements will be specified accordingly.

Applicable occupational exposure limits are addressed in USDOE Order 5480.11. These limits consider the exposures that may occur from all pathways, and relate to worker protection.

USDOE Order 5400.5 requires USDOE facilities and their contractors to implement As Low As Reasonably Achievable (ALARA) controls to emissions and discharges containing radionuclides. ALARA is a discretionary level of control that goes beyond regulatory requirements. For the purposes of this design, ALARA is applied to the control of dust emissions by covering potential sources and maintaining negative air pressure at those sources, and by applying High Efficiency Particulate Air (HEPA) Filters to all vents and exhausts from potential dust sources.

Since no liquid discharges are anticipated from the proposed treatment facility, no standards related to discharges will apply.

3.2.4 Regulatory Criteria

The following environmental regulatory criteria apply:

- TUs can operate for no more than one year. Therefore, the sludges must be completely processed within this period.

- Transfer of materials between the tents by conveyors, transfer lines, or by means other than vehicles will require the use of secondary containment.

- Closure of the interim storage tanks is beyond the scope of this project.

3.2.5 Health and Safety Criteria

The following health and safety related criteria apply:

- A Health and Safety Plan (HASP), prepared in accordance with the ASRP Health and Safety Plan, will be required prior to any processing or placement of remediation wastes. The HASP will address medical monitoring requirements, industrial hygiene monitoring for heavy metals, and radiation dose monitoring.

- Operational guidance described in the HASP will be observed by the operators.

- Personal Protective Equipment will be worn by operators in accordance with the HASP.

- All operators will be provided with 40 hour hazardous materials training in accordance with 29 CFR 1910.120 prior to engaging in remediation activities.

- All operators will be provided with instruction in accordance with the Federal Hazard Communication Standard (29 CFR 1910.120) prior to engaging in remediation activities.

- All operators will undergo site-specific radiation worker training prior to engaging in remediation activities.

All operations will be conducted in accordance with the USDOE Radiation Control Manual and the Rocky Flats Plant radiation protection requirements. This White Paper assumes that all Health & Safety monitoring required by the HASP will be performed by EG&G Rocky Flats.

4.0 VALUE ENGINEERING STUDY

The waste sludges from the Rocky Flats Solar Evaporation Ponds 207A, 207B, 207C and the Building 788 Clarifier are currently in interim storage in 66 10,000-gallon, double-contained, high-density polyethylene tanks located in tents on the 750 Pad. These sludges will be removed from the tanks; treated with lime to destroy any pathogens and gas-producing micro-organisms, and mixed with pozzolans and/or bulking agents to produce a treated waste which satisfies the WAC (Section 3.1.1) for the OU-4 Interim Remedial Action (IRA) closure area.

The pond sludge treatment system will consist of the following unit operations:

- Sludge removal and transfer
- Treatment additives handling
- Treatment/blending of sludge and additive(s)
- Treated waste handling and testing
- Treated waste transfer to OU-4 closure area

In this section of the White Paper, a Value Engineering Study is conducted to identify the most effective treatment alternative based on an evaluation exercise that utilizes the following evaluation criteria: effectiveness, implementability, operability and cost. The recommended treatment alternative is selected from a short list of five potentially applicable treatment options, which were chosen for evaluation based on the results of previous characterization studies and treatability testing conducted by HNUS.

In the following sections, the evaluation criteria are described in further detail and a brief description of the candidate alternatives is presented. The alternatives are evaluated and the recommended alternative is identified.

4.1 EVALUATION CRITERIA

The four criteria that were used for the evaluation of the pond sludge treatment alternatives are as follows:

- Effectiveness
- Implementability
- Operability
- Cost

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4.1.1 Effectiveness

The effectiveness of each treatment alternative was evaluated by determining its ability to produce a treated waste which will consistently meet the WAC as defined in Section 3.1.1.

4.1.2 Implementability

The implementability of each treatment alternative was evaluated by determining, in general, how easily and rapidly it could be installed and put into operation. In particular, the following specific factors were taken into consideration:

- The overall areal and vertical dimensions of the treatment equipment involved were compared to the floor space and overhead clearances available to determine how well this equipment would fit within the available space limitations.

- The electrical power requirements of the treatment equipment were estimated to determine how electric power demands would impact existing plant power supplies.

- The availability and procurement lead times of the treatment equipment were determined to assess their potential impact on the overall project schedule.

- Each treatment process was evaluated to determine whether its technical feasibility and effectiveness could be readily tested by the treatability study as planned or if significant treatability testing (and therefore schedule) changes would be required.

4.1.3 Operability

The operability of each treatment alternative was evaluated by determining, in general, how simple it would be to operate, control, and maintain. In particular, the following specific factors were taken into consideration:

- The sensitivity of the treatment process to changes in waste composition, waste flow, and additive feed rate was evaluated to determine the range of operational conditions under which the alternative could effectively perform and produce an acceptable treated waste.

- The complexity of the treatment process and equipment was assessed to determine how difficult it would be to properly operate. As part of this factor, the amount of operational supervision required was also determined as well as the necessary level of operating personnel skill and the need for special training.

- The reliability of the treatment equipment and controls was evaluated to assess the potential for malfunctioning and breakdown, to determine the need for spare/stand-by equipment, and to estimate expected downtime.

- The maintenance requirements of the treatment equipment were evaluated to determine the amount and frequency of maintenance required, the level of skill of maintenance personnel, the need for special training, and the amount of spare parts and/or special tools necessary.

- The decontamination and decommissioning of the treatment equipment was evaluated to establish the technical complexity and labor requirements of this decommissioning, the need for special health and safety considerations, and the means of ultimate equipment disposal.

4.1.4 Cost

Budget-type estimates were prepared to compare the relative capital expenditures, operating and maintenance costs, and decontamination and decommissioning costs of the various treatment alternatives.

4.2 TREATMENT ALTERNATIVES

Following are brief process descriptions of the candidate pond sludge treatment alternatives. To simplify the evaluation of treatment alternatives, it is assumed that, regardless of the treatment process, the pond sludges will be removed from the temporary storage tanks in the same manner as described in Section 4.1 of the Accelerated Sludge Processing Conceptual Design White Paper, dated August 24, 1994 and in Section 5.1 of this White Paper. Accordingly the following subsections will only describe alternative treatment processes, since they are the differentiating factor when the alternatives are compared.

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The treatment alternatives evaluated generate a range of end-products which can be produced by the solidification/stabilization of sludges. They all include mixing with one or more treatment additives plus one of the following steps:

- Agglomeration of the treated waste in spherical-shaped pellets
- Extrusion of the treated waste as a ribbon and cutting into cylindrical-shaped pellets
- Agglomeration of the treated waste in pillow-shaped briquettes
- Casting of the treated waste into monolithic blocks
- Production of a treated waste friable mix

Whenever more than one process option was available for a given treatment alternative, the option selected for evaluation was that which was believed to be most representative and most likely to be successful for the treatment of the Rocky Flats solar pond sludges.

4.2.1 <u>Pelletizing</u>

A block flow diagram of the pelletizing treatment process is provided on Figure 1. The objective of this process is to treat the pond sludges to form spherical pellets which meet the WAC for placement in the OU-4 closure area. For this purpose, the pond sludges are first thoroughly blended with a pozzolanic agent mix, such as cement/lime, to impart to them the desired plasticity and to destroy any pathogens and gas-generating micro-organisms that may be present. The treated waste is then agglomerated into spherical-shaped pellets of controlled size with the help of a surface-drying agent, such as cement or lime. The treated waste pellets are then cured, tested, and transferred for placement in the OU-4 closure area.

This system consists of two Additive Storage and Feed Units (ASFUs), one Mixing and Pelletizing Treatment Unit (MPTU) and three Treated Waste Storage and Transport Units (TSTUs).

One of the ASFUs stores and feeds the pozzolanic agent mix and the other stores and feed the surface-drying agent. Each ASFU consists of a Storage Silo (T-1 or T-2) and an Additive Feed System (AFS-1 or AFS-2). The configuration of each Storage Silo is vertical/cylindrical with a 60° cone bottom. Each silo is equipped with a pneumatic unloading connection, level sensing devices, and a passive dust control device. Each Additive Feed System consists of a variable-speed rotary feeder, a weigh-belt conveyor, and a screw feeder. For each ASFU, the additive is delivered to the site and unloaded into the storage silo by a bulk transport truck equipped with a pneumatic delivery system. The additive is unloaded from the bottom of the storage silo by the rotary feeder onto the weigh-belt conveyor which automatically adjusts the speed of the rotary feeder to provide the desired rate of additive feed. The controlled quantity of additive is then

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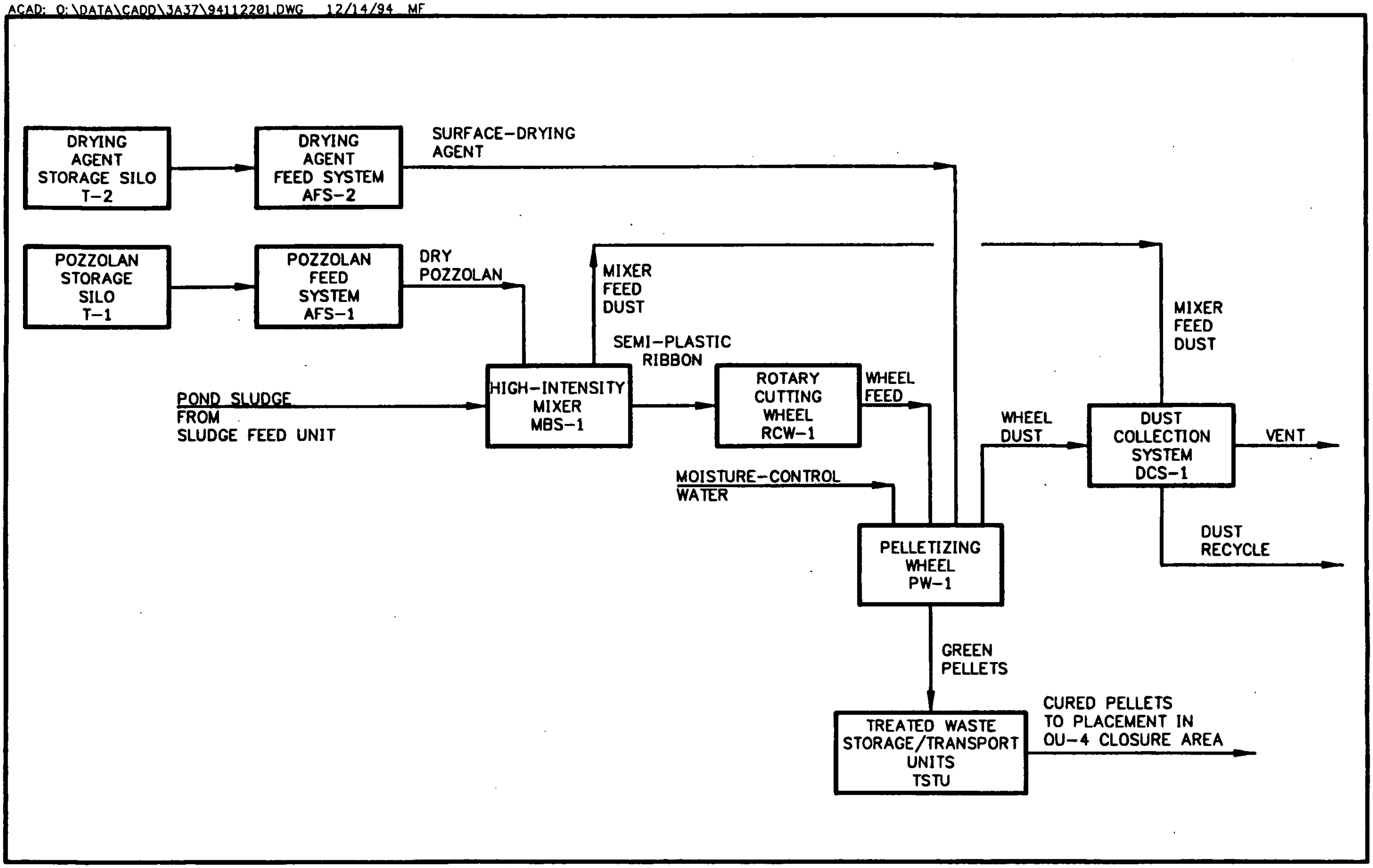

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FIGURE 1
PROCESS BLOCK FLOW DIAGRAM
PELLETIZING TREATMENT SYSTEM
207A, 207B, 207C SOLAR PONDS SLUDGE
EG&G ROCKY FLATS, GOLDEN, COLORADO

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transferred to the delivery point by a screw conveyor. The delivery point of the pozzolanic agent mix is in the High-Intensity Mixer of the MPTU and that of the surface-drying agent is in the Pelletizing Wheel of the MPTU.

The MPTU consists of a High-Intensity Mixer (MBS-1), a Rotary Cutter Wheel (RCW-1), a Pelletizing Wheel (PW-1), a Pellet Transfer Conveyor (CS-1), a Treated Waste Container Jockey System (JS-1), and a Pelletizing Wheel Dust Collector (DCS-1). The High-Intensity Mixer is of the gear-lobe type with low volume/low-residence time. This mixer blends the pond sludge with the desired quantity of pozzolanic agent mix to form a semi-plastic ribbon of treated waste. This ribbon is then cut by the Rotary Cutter Wheel into 0.5-inch cubes which are fed into the Pelletizing Wheel. The Pelletizing Wheel consists of an inclined rotating tray which transforms the treated waste cubes into 0.5- to 0.75-inch-diameter spherical treated waste pellets with the help of the controlled addition of a surface-drying agent and water spray. The spherical pellets of treated waste are directly discharged from the Pelletizing Wheel into one of the TSTUs. The Treated Waste Container Jockey System slowly moves the TSTU along a short length of track with a winch and pulley system to evenly distribute pellets inside the container. Dust generated by the pelletizing operation is captured by the Pelletizing Wheel Dust Collector. This dust collector consists of a baghouse collector, an exhaust fan, and a HEPA-type exhaust air filter. Excess dust accumulated in the collector is periodically removed for reprocessing through the treatment system.

Each of the TSTUs consists of a roll-off type container featuring an end-dump gate and small bottom steel wheels. To prevent dust emissions, each TSTU is fitted with a removable top cover. Once full, each TSTU is moved to a staging/curing area where it is stored for a period of approximately one day. At the end of this time, the contents of each TSTU are field-tested for adherence to the WAC and, upon successful completion of these tests, the TSTU is trucked to the OU-4 closure area, dumped and returned to the treatment area for reuse.

4.2.2 Extrusion

A block flow diagram of the extrusion treatment process is provided on Figure 2. The extrusion treatment process is somewhat similar to the pelletizing treatment process, except that the objective of this process is to treat the pond sludges to form cylindrical, rather than spherical, pellets. As with the pelletizing treatment process, the pond sludges are first thoroughly blended with a pozzolanic agent mix, such as cement/lime, to impart to them the desired plasticity and to destroy pathogens and gas-generating micro-organisms. The semi-plastic treated waste is then extruded into a cylindrical shape, cut into pellets, and surface-treated with a drying agent, such as lime or cement. The treated waste pellets are then cured and transferred for placement in the OU-4 closure area.

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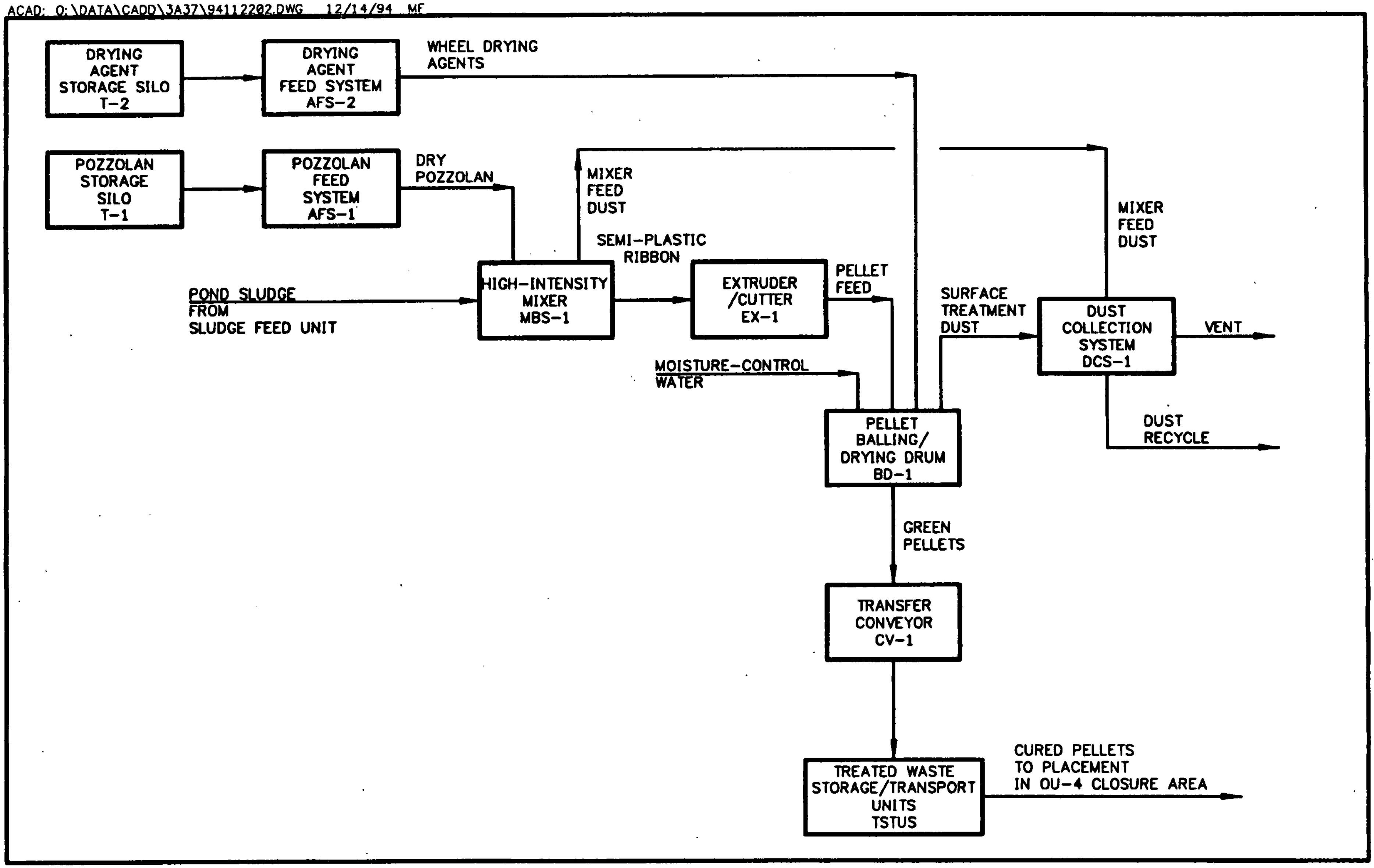

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FIGURE 2
PROCESS BLOCK FLOW DIAGRAM
EXTRUSION TREATMENT SYSTEM
207A, 207B, 207C SOLAR PONDS SLUDGE
EG&G ROCKY FLATS, GOLDEN, COLORADO

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This system consists of two Additive Storage and Feed Units (ASFUs), one Mixing/Extrusion/Pelletizing Unit (MEPU), and three Treated Waste Storage and Transport Units (TSTUs).

One of the ASFUs of the Extrusion Treatment System stores and feeds a pozzolanic agent mix and the other stores and feeds a surface-drying agent. The equipment and operation of these ASFUs are identical to those described in Section 4.2.2 of this White Paper for the Pelletizing Treatment System ASFUs. The delivery point of the pozzolanic agent mix is in the High-Intensity Mixer of the MEPU and the delivery point of the surface-drying agent is in the Pellet Balling/Drying Drum of the MEPU.

The MEPU consists of a High-Intensity Mixer (MBS-1), an Extruder (EX-1), a Pellet Balling/Drying Drum (BD-1), a Pellet Transfer Conveyor (CV-1), a Treated Waste Container Jockey System (JS-1), and a Balling Drum and Conveyor Dust Collector (DCS-1). The High-Intensity Mixer is of the gear-lobe type with low volume/low-residence time. This mixer blends the solar pond sludges with the desired quantity of pozzolanic agent mix to form a semi-plastic material which is fed into the Extruder. The Extruder consists of an impeller which forces the semi-plastic treated waste into a cylindrical extrusion die which shapes it into a 0.5-inch ribbon. This ribbon is then cut into 0.75-inch-long cylindrical pellets by a rotary wheel cutter attachment. The treated waste pellets are then transferred to the Pellet Balling/Drying/Drum where they are tumbled with the surface-drying agent. The dried treated waste pellets are dropped onto the Pellet Transfer Conveyor which transport them to one of the TSTUs. The Treated Waste Container Jockey System slowly moves the TSTU along a short length of track with a winch and pulley system to evenly distribute pellets inside the container. Dust generated by the pellet drying and conveying operations is captured by the Balling Drum and Conveyor Dust Collector. This dust collector consists of a baghouse collector, an exhaust fan, and a HEPA-type exhaust air filter. Excess dust accumulated in the collector is periodically removed for reprocessing through the treatment system.

Each of the TSTUs consists of a roll-off type container featuring an end-dump gate and small bottom steel wheels. To prevent dust emissions, each TSTU is fitted with a removable top cover. Once full, each TSTU is moved to a staging/curing area where it is stored for a period of approximately one day. At the end of that time, the contents of each TSTU are field-tested for adherence to the WAC and, upon successful completion of these tests, the TSTU is trucked to the OU-4 closure area, dumped and returned to the treatment area for reuse.

4.2.3 Briquetting

A block flow diagram of the briquetting treatment process is provided on Figure 3. The briquetting treatment process is somewhat similar to the pelletizing and extrusion treatment processes, except that the objective of this process is to treat the pond sludges to form treated waste into pillow-shaped briquettes, rather than spherical or cylindrical pellets. As with the pelletizing and extrusion treatment processes, the pond sludges are first thoroughly blended with a pozzolanic agent mix, such as cement/lime, to impart to them the desired plasticity and to destroy pathogens and gas-generating micro-organisms. The semi-plastic treated waste is then formed into briquettes which are cured, tested, and transferred for placement in the OU-4 closure area.

This system consists of one Additive Storage and Feed Unit (ASFU), one Mixing and Briquetting Treatment Unit (MBTU), and three Treated Waste Storage and Transport Units (TSTUs).

The ASFU of the Briquetting Treatment System stores and feeds the pozzolanic agent mix. The equipment and operation of this ASFU are identical to those described in Section 4.2.2 of this report for the Pelletizing Treatment System ASFUs. The delivery point of the pozzolanic agent mix is in the High-Intensity Mixer of the MBTU.

The MBTU consists of a High-Intensity Mixer (MBS-1), a Briquetting Machine (BM-1), a Briquette Transfer Conveyor (CV-1), and a Treated Waste Container Jockey System (JS-1). The High-Intensity Mixer is of the gear-lobe type with low volume/low-residence time. This mixer blends the solar pond sludges with the desired quantity of pozzolanic agent mix to form a semi-plastic material which is fed into the Briquetting Machine feed hopper. In the Briquetting Machine, a screw auger feeds the treated waste to a double-roll counter-rotating press which shapes it in pillow-like compacted briquettes. The treated waste briquettes are dropped onto the Briquette Transfer Conveyor which transport them to one of the TSTUs. The Treated Waste Container Jockey System slowly moves the TSTU along a short length of track with a winch and pulley system to evenly distribute briquettes inside the container.

Each of the TSTUs consists of a roll-off type container featuring an end-dump gate and small bottom steel wheels. To prevent dust emissions, each TSTU is fitted with a removable top cover. Once full, each TSTU is moved to a staging/curing area where it is stored for a period of approximately one day. At the end of this time, the contents of each TSTU are field tested for adherence to the WAC and, upon successful completion of these tests, the TSTU is trucked to the OU-4 closure area, dumped and returned to the treatment area for reuse.

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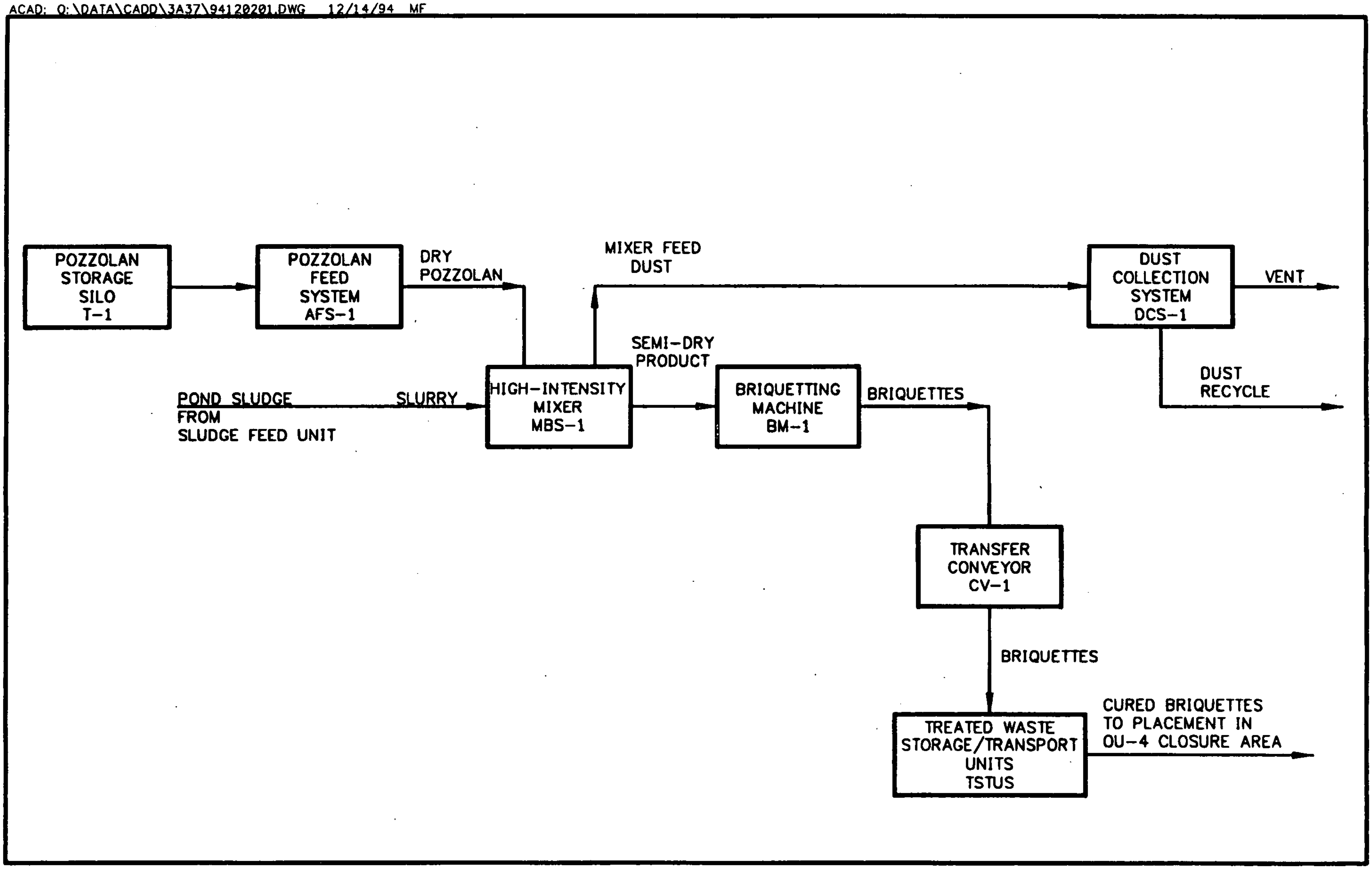

FIGURE 3
PROCESS BLOCK FLOW DIAGRAM
BRIQUETTING TREATMENT SYSTEM
207A, 207B, 207C SOLAR PONDS SLUDGE
EG&G ROCKY FLATS, GOLDEN, COLORADO

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4.2.4 Monolithic Casting

A block flow diagram of the monolithic casting treatment process is provided on Figure 4. The objective of this process is to treat the pond sludges to cast treated waste blocks (monoliths) which will meet the WAC for placement in the OU-4 closure area. For this purpose, the pond sludges are thoroughly blended with a pozzolanic agent mix to impart to them the desired cohesiveness and to destroy pathogens and gas-generating micro-organisms. The pond sludges are also blended with a solidification-accelerating agent to quicken the curing process. The treated waste is then cast into blocks which are cured, tested, and transferred for placement in the OU-4 closure area.

This system consists of two Additive Storage and Feed Units (ASFUs), one Mixing and Casting Treatment Unit (MCTU), and 20 Treated Waste Storage and Transport Units (TSTUs).

One of the ASFUs stores and feeds a pozzolanic agent mix and the other stores and feeds a solidification-accelerating agent. The equipment and operation of the pozzolanic agent mix ASFU are identical to those described in Section 4.2.2 of this White Paper for the Pelletizing Treatment System ASFUs. The solidification-accelerating agent ASFU consists of a cone-bottom storage/feed hopper and a single-screw precision volumetric feeder to regulate the delivery rate of this agent. The delivery point of both the pozzolanic agent mix and solidification-accelerating agent is in the High-Intensity Mixer of the MCTU.

The MCTU consists of a High-Intensity Mixer (MBS-1), a Conveying Caster (CV-1), and a Treated Waste Container Jockey System (JS-1). The High-Intensity Mixer is of the gear-lobe type with low volume/low-residence time. This mixer blends the pond sludges with the desired quantities of pozzolanic agent mix and solidification-accelerating agent to form a liquid or semi-plastic material which is discharged onto the Conveying Caster, where it hardens into monolithic blocks in the pockets of the flexible conveying belt. The rate of solidification-accelerating agent addition and the speed of the Conveying Caster belt are adjusted to provide adequate setting of the treated waste blocks. The Conveying Caster discharges the treated waste blocks to one of the TSTUs. The Treated Waste Container Jockey System slowly moves the TSTU along a short length of track with a winch and pulley system to evenly distribute blocks inside the container.

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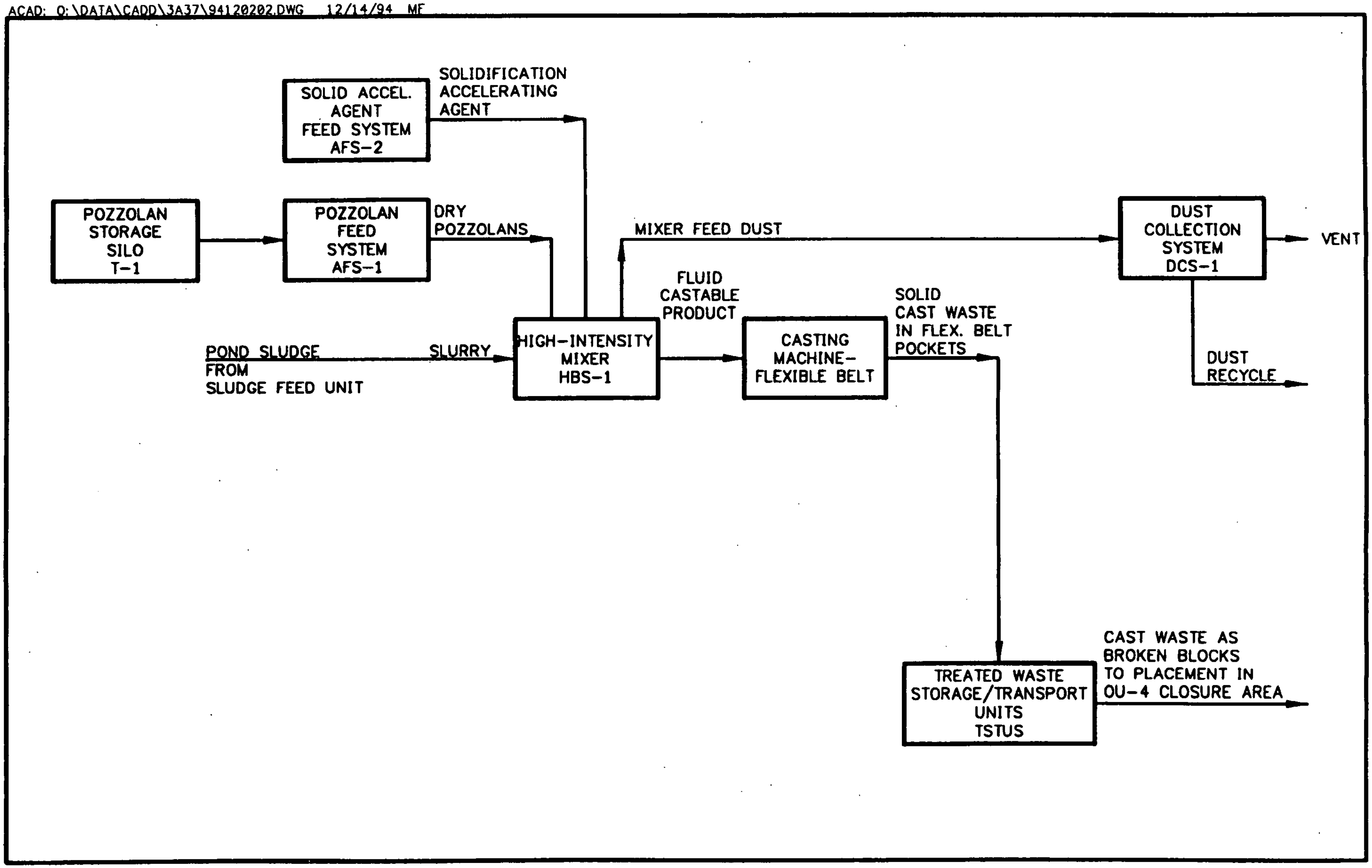

FIGURE 4
PROCESS BLOCK FLOW DIAGRAM
MONOLITHIC CASTING TREATMENT SYSTEM
207A, 207B, 207C SOLAR PONDS SLUDGE
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The rationale for selecting a conveying caster, instead of molds, for the shaping of monolithic blocks of treated waste is as follows:

- The use of a conveying caster will simplify the operation of a monolithic casting treatment system by eliminating the labor-intensive handling of molds.

- The use of a conveying caster will result in the production of smaller monolithic blocks of treated waste which will cure faster, and can be handled and stored in conventional roll-off containers.

Each of the TSTUs consists of a roll-off type container featuring an end-dump gate and small bottom steel wheels. To prevent dust emissions, each TSTU is fitted with a removable top cover. Once full, each TSTU is moved to a staging/curing area where it is stored for a period of approximately five days. At the end of that period, the contents of each TSTU are field-tested for adherence to the WAC and, upon successful completion of these tests, the TSTU is trucked to the OU-4 closure area, dumped and returned to the treatment area for reuse.

4.2.5 Friable Product

A block flow diagram of the friable product treatment process is provided on Figure 5. The objective of this process is to treat the pond sludges to produce a friable mix which will meet the WAC for placement in the OU-4 closure area. For this purpose, the pond sludges are thoroughly blended with a relatively dry bulking agent, such as sand or flyash, and with a pozzolanic agent mix, such as cement/lime. The bulking agent adsorbs the majority of the free moisture and imparts the required cohesiveness to the treated waste. The pozzolanic agent mix adsorbs additional moisture, provides the necessary treated waste stabilization, and destroys pathogens and gas-generating micro-organisms. The treated waste is then cured, tested, and transferred for placement in the OU-4 closure area.

This system consists of two Additive Storage and Feed Units (ASFUs), one Mixing Treatment Unit (MTU), and 8 Treated Waste Storage and Transport Units (TSTUs).

One of the ASFUs stores and feeds the bulking agent and the other stores and feeds the pozzolanic agent mix. The equipment and operation of these ASFUs are identical to those described in Section 4.2.2 of this report for the Pelletizing Treatment System ASFUs. The delivery point of both the bulking agent and pozzolanic agent mix is in the Mixing/Blending System of the MTU.

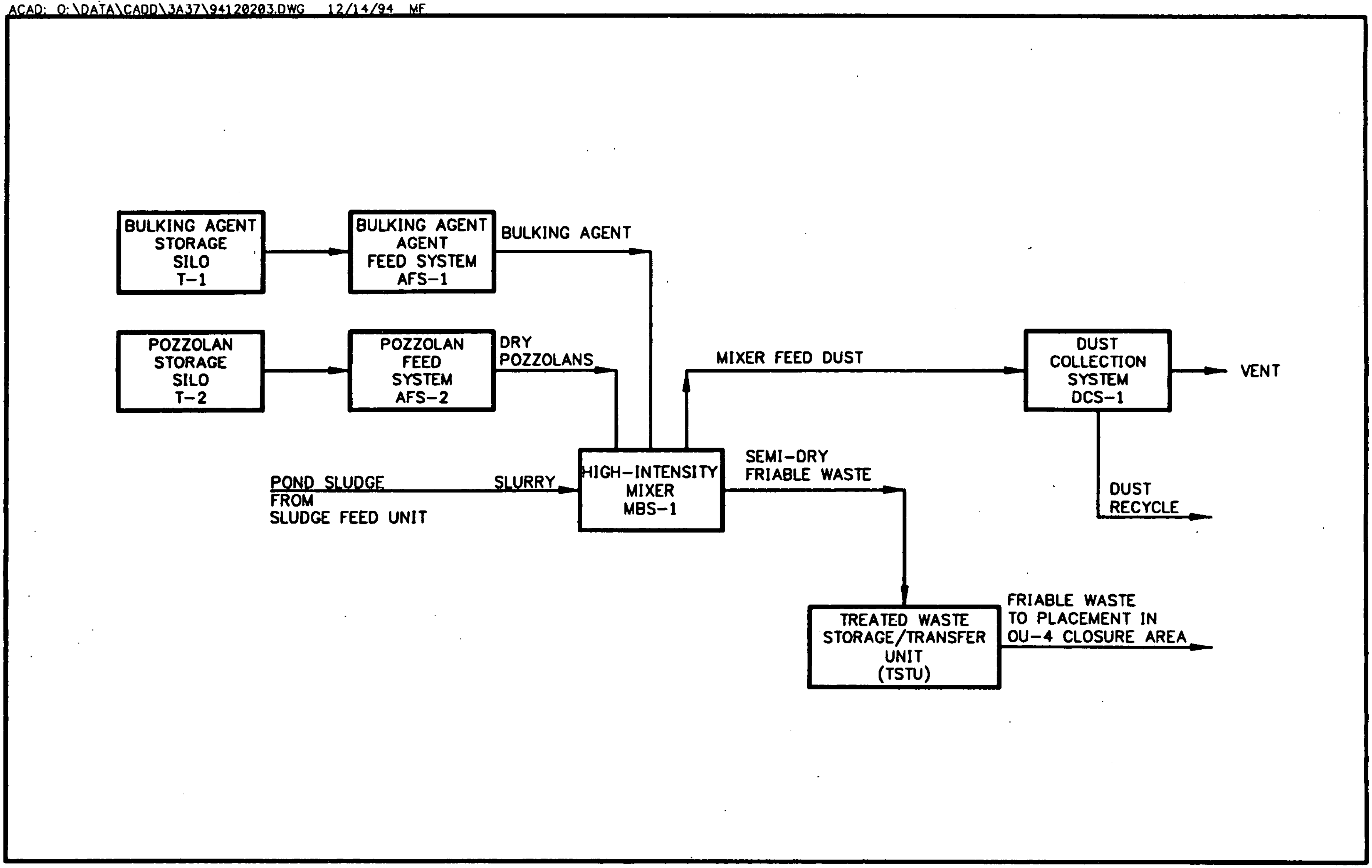

FIGURE 5
PROCESS BLOCK FLOW DIAGRAM
FRIABLE PRODUCT TREATMENT SYSTEM
207A, 207B, 207C SOLAR PONDS SLUDGE
EG&G ROCKY FLATS, GOLDEN, COLORADO

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The MTU consists of a Mixing/Blending System (MBS-1), a Treated Waste Container Jockey System (JS-1), and a Mixing/Blending System Dust Collector (DCS-1). The Mixing/Blending System consists of a Turbulator-type pre-mixer, a pug-mill type mixing device, and a belt-type conveyor and discharge chute. In the Mixing/Blending System, the pond sludges are first blended in the pre-mixer to ensure proper pozzolanic agent wetting. The blend of sludge and pozzolanic agent mix is then combined with the bulking agent in the pug mill and the treated waste is discharged as a friable mix into one of the TSTUs by the belt-type conveyor. The Treated Waste Container Jockey System slowly moves the TSTU along a short length of tracks with a winch and pulley system to evenly distribute friable product inside the container. Dust generated by the operation of the Mixing/Blending System is captured by the Mixing/Blending System Dust Collector. This dust collector consists of a baghouse collector, an exhaust fan, and a HEPA-type exhaust air filter. Excess dust accumulated in the collector is periodically removed for reprocessing through the treatment system.

Each of the TSTUs consists of a roll-off type container featuring an end-dump gate and small bottom steel wheels. To prevent dust emissions, each TSTU is fitted with a removable top cover. Once full, each TSTU is moved to a staging/curing area where it is stored for a period of approximately two days. At the end of that period, the contents of each TSTU is field-tested for adherence to the WAC and, upon successful completion of these tests, the TSTU is trucked to the OU-4 closure area, dumped and returned to the treatment area for reuse.

4.2.6 Treated Waste Volumes

A summary of the uncompacted (bulk) volume of treated waste generated by the five sludge treatment alternatives is provided on Table 2.

TABLE 2

ESTIMATED UNCOMPACTED TREATED WASTE VOLUMES

Waste	Uncompacted Treated Waste Volume (CY)				
	Pelletizing	Extruding	Briquetting	Monolithic Casting	Friable Product
Ponds 207 A & B and 788 Clarifier	2,990	2,730	2,870	2,178	3,860
Pond 207 C	6,430	5,760	6,750	4,358	7,280
TOTAL	9,420	8,490	9,620	6,536	11,140

As shown on Table 2, the volumes of treated waste which would be generated by the pelletizing, extruding, and briquetting sludge treatment alternatives are roughly comparable. Also as shown on Table 2, the volume of treated waste which would be generated by the monolithic casting alternative is lower than that of the other alternatives and the volume of treated waste generated by the friable product alternative is somewhat larger than that of the other alternatives. The actual swell volume of the selected alternative will be measured in the treatability study.

4.3 ALTERNATIVE EVALUATION

In this section of the White Paper, the sludge treatment alternatives are evaluated using the criteria presented in Section 4.1. The goal of the evaluation is to identify the treatment alternative that will satisfy the requirements of the closure area WAC in the most efficient, reliable, and cost-effective manner, given the operating constraints present at the Rocky Flats plant. The evaluation of sludge treatment alternatives is summarized on Table 3.

4.3.1 Effectiveness

All five sludge treatment alternatives evaluated can generate a treated waste that will meet all of the WAC requirements for placement in the OU-4 closure area.

4.3.2 Implementability

Space Requirements

All five sludge treatment alternatives evaluated can fit within Tent 12 on the 750 pad. There are, however, some slight concerns about the space requirements of the equipment for the pelletizing and monolithic casting alternatives. Specifically, the height of the pelletizing wheel (expected to be over 15 feet) in the pelletizing alternative may not allow sufficient vertical clearance, and the number and length of the conveying casters in the monolithic casting alternative may be difficult to accommodate within the available surface area.

Electrical Power Requirements

The electrical power requirements of all five sludge treatment alternatives evaluated can be satisfied by existing plant power supplies.

TABLE 3
POND SLUDGE TREATMENT VALUE ENGINEERING EVALUATION MATRIX

Alternative	Effectiveness	Implementability	Operability	Cost
	• Satisfies WAC requirements.	• Footprint and vertical clearance requirements. • Electrical power requirements. • Equipment procurement lead times. • Treatability testing requirements.	• Sensitivity to changes in waste properties. • Process operations complexity. • Equipment/control system reliability. • Maintenance requirements. • Operator Skill/Training Requirements	• Capital • Operating & Maintenance • Decontamination and Decommissioning
Pelletizing	• Expected to produce a treated waste that will meet all WAC requirements.	• Potential height limitation on equipment. • Potential long-lead procurement time for equipment, which could negatively impact project schedule. • Would require an adjustment to the treatability testing scope-of-work, which could negatively impact project schedule.	• Very sensitive to changes in waste properties; must operate at precise water to pozzolan to waste solids ratios. • Requires intensive operator attention during process operations; operators must be thoroughly trained and knowledgeable. • Relatively complex equipment/control systems could result in greater down-times. • Requires relatively more maintenance/cleanup effort due to complexity and sensitivity of operations.	Capital $3,200,000 O&M $4,600,000 D&D $180,000 Total $7,980,000
Extruding	• Expected to produce a treated waste that will meet all WAC requirements.	• Potential long-lead procurement time for equipment, which could negatively impact project schedule. • Would require an adjustment to the treatability testing scope-of-work, which could negatively impact project schedule.	• Very sensitive to changes in waste properties;must operate at precise water to pozzolan to waste solids ratios to remain near plastic limit; may have particular difficulty in effectively treating C-Pond waste in a consistent manner. • Requires intensive operator attention during process operations; operators must be thoroughly trained and knowledgeable. • Relatively complex equipment/control systems could result in greater down-times. • Requires relatively more maintenance/cleanup effort due to complexity and sensitivity of operations.	Capital $3,400,000 O&M $4,200,000 D&D $180,000 Total $7,780,000

TABLE 3 (Continued)
POND SLUDGE TREATMENT VALUE ENGINEERING EVALUATION MATRIX

Alternative	Effectiveness	Implementability	Operability	Cost
	• Satisfies WAC requirements.	• Footprint and vertical clearance requirements. • Electrical power requirements. • Equipment procurement lead times. • Treatability testing requirements.	• Sensitivity to changes in waste properties. • Process operations complexity. • Equipment/control system reliability. • Maintenance requirements.	• Capital • Operating & Maintenance
Briquetting	• Expected to produce a treated waste that will meet all WAC requirements.	• Potential long-lead procurement time for equipment, which could negatively impact project schedule. • Would require an adjustment to the treatability testing scope-of-work; which could negatively impact project schedule.	• Very sensitive to changes in waste properties; must operate within a narrow range for the water to pozzolan to waste solids ratio to remain near plastic limit. • Requires intensive operator attention during process operations; operators must be thoroughly trained and knowledgeable. • Relatively complex equipment/control systems could result in greater down-times. • Requires relatively more maintenance/cleanup effort due to complexity and sensitivity of operations.	Capital $3,700,000 O&M $4,700,000 D&D $170,000 Total $8,570,000
Monolithic Casting	• Expected to produce a treated waste that will meet all WAC requirements.	• Relatively large storage space is required to satisfy materials handling and monolith curing requirements. • Mixing equipment may have a long-lead procurement time, which could negatively impact project schedule. • No adjustment required to present treatability testing scope.	• Wider operating range for water to pozzolan to waste solids ratios. • Mold curing adds complexity. • Process operation interruption could result in solidification of process equipment.	Capital $2,600,000 O&M $2,900,000 D&D $170,000 Total $5,670,000
Friable Product	• Expected to produce a treated waste that will meet all WAC requirements.	• Relatively large materials handling and storage requirements due to bulking agent volume. • No adjustment required to present treatability testing scope. • Requires relatively more additive (bulking agent and pozzolan) truck deliveries and resultant treated waste truck deliveries. • Equipment is readily available; procurement should not impact project schedule.	• Widest operating range for water to pozzolan to waste solids ratios. • Relatively simple process, operations. • Relatively simple equipment/control systems could result in fewer down-times. • Relatively easy to maintain.	Capital $2,200,000 O&M $2,700,000 D&D $170,000 Total $5,070,000

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Availability and Procurement Lead Times

The equipment for the pelletizing, extruding, and briquetting sludge treatment alternatives is somewhat specialized and is not expected to be readily available. Procurement lead time for this equipment may extend six months or more, which would significantly impact the overall project schedule.

The equipment for the monolithic casting sludge treatment alternative is expected to be somewhat more available than that of the pelletizing, extruding, and briquetting alternatives, but the procurement lead time is still expected to extend beyond four months, which would also impact the overall project schedule.

The equipment for the friable product sludge treatment alternative is of a relatively standard type and is expected to be readily available. As a result the procurement lead time should not extend beyond two months and would have no significant impact on the overall project schedule.

Impact on Treatability Study

Selection of either the pelletizing, extruding, or briquetting sludge treatment alternatives as the recommended alternative would have a considerable impact on the execution of the upcoming pond sludge treatability study, as testing of the effectiveness of these technologies is not planned in the current scope of work (SOW) of this study. Testing any of these alternatives would result in a lengthier treatability study which, in turn, would impact the overall project schedule. Pilot testing of this equipment would be required to confirm that this equipment is capable of treating Pond A/B and C material.

Selection of either the monolithic casting or friable product sludge treatment alternatives as the recommended alternative would have no impact on the upcoming pond sludge treatability study, as the testing of these technologies is part of the current study SOW.

4.3.3 Operability

Sensitivity to Changes in Operating Conditions

The pelletizing, extruding, and briquetting sludge treatment alternatives are very sensitive to changes in the characteristics of the incoming sludges. The process of each of these alternatives must operate at a relatively precise water-to-pozzolan-to-waste solids ratio to form a treated waste with the required plasticity. Therefore the operating range of these sludge treatment alternatives would be very narrow and even slight variances from optimum operating parameters would lead to generation of an unacceptable treated waste, and would require extensive equipment clean-up and reprocessing of the off-spec treated waste.

The monolithic casting sludge treatment alternative would be somewhat less sensitive than the pelletizing, extruding, and briquetting alternatives to changes in the characteristics of the incoming sludge and in the feed rate of the treatment additives. Previous treatability studies have defined operating ranges for key operating parameters, including waste loading and water/pozzolan ratios. For this option, curing time is a critical parameter. Shorter curing times result in smaller space requirements for curing. Control of the solidification-accelerating agent feed rate and the conveying caster operating rate are critical operating parameters.

The friable product sludge treatment alternative would be relatively insensitive to changes in the characteristics of the incoming sludges. When compared with the other sludge treatment alternatives, the friable product alternative would operate satisfactorily over a much wider range of conditions.

Equipment Complexity and Operating Personnel Qualifications/Training Requirements

The equipment for the pelletizing, extruding, and briquetting sludge treatment alternatives is more complex and specialized than that of the other alternatives and would be complicated to operate. Due to the process sensitivity to slight changes in feed material composition, the operators would have to be able to adjust operating parameters during operation to maintain a consistent product. Operating personnel would therefore need to be highly skilled and would require specialized training.

The equipment for the monolithic casting sludge treatment alternative is less complex and specialized than that of the pelletizing, extruding, and briquetting alternatives, but it would still be relatively complex to operate. The successful operation of a monolithic casting process is dependent on producing a cured product within a defined time frame. The operator would need to adjust chemical feed rates in response to changing feed conditions to achieve the desired cure time. Operating personnel qualification and specialized training requirements would also be less stringent but still significant.

The equipment for the friable product sludge treatment alternative would essentially consists of standard solids material blending and conveying equipment and would be simplest to operate than that for any other alternatives. Operating personnel qualifications would be less stringent than for the other alternatives and specialized training requirements would be minimal.

Equipment and Controls Reliability

Due to their complexity, the equipment and controls for the pelletizing, extruding, and briquetting sludge treatment alternatives would be generally less reliable and more susceptible to break-down than those for the other alternatives. The need for spare/stand-by equipment for these alternatives would be relatively high if downtime is to be minimized.

The equipment and controls for the monolithic casting sludge treatment alternative would be less complex and more reliable than those for the pelletizing, extruding, and briquetting alternatives but some breakdowns, in particular with the conveying casters, could still be expected. Accordingly, spare/stand-by equipment would be required to minimize downtime.

The equipment and controls for the friable product sludge treatment alternative are less complex and would be more reliable than those for the other alternatives. Although breakdown of this equipment may occur, it should be relatively easy to fix and the need for spare/stand-by equipment should be minimal.

Maintenance Requirements

The maintenance requirements for the equipment of the pelletizing, extruding, briquetting, and monolithic casting sludge treatment alternatives would be demanding and frequent. Highly qualified and specially trained maintenance personnel would be required for these alternatives.

The maintenance requirements for the equipment of the friable product sludge treatment alternative would be less demanding than those for the other alternatives. Maintenance personnel qualifications would also not to be as high and specialized training requirements would be minimal.

Decommissioning Requirements

The decommissioning requirements for all five sludge treatment alternatives evaluated would be extensive. Special health and safety considerations and equipment disposal considerations are anticipated to be comparable.

4.3.4 Cost

A comparison of budget-type capital expenditure, operating and maintenance costs, and decontamination and decommissioning cost estimates for the five sludge treatment alternatives evaluated is provided on Table 4.

TABLE 4

ALTERNATIVE COST ESTIMATES

Costs	Pelletizing	Extruding	Briquetting	Monolith Casting	Friable Product
Capital	$3,200,000	$3,400,000	$3,700,000	$2,600,000	$2,200,000
Operating & Maintenance	$4,600,000	$4,200,000	$4,700,000	$2,900,000	$2,700,000
Decontamination & Decommissioning	$180,000	$180,000	$170,000	$170,000	$170,000
TOTAL	**$7,980,000**	**$7,780,000**	**$8,570,000**	**$5,670,000**	**$5,070,000**

As can be seen from the figures on this table, the estimated capital expenditure and operating and maintenance costs for the friable mix sludge treatment alternative are lower than those for the other alternatives. Decontamination and decommissioning costs are essentially equal for all five alternatives evaluated.

4.4 RECOMMENDED ALTERNATIVE

Based on the results of the pond sludge treatment alternatives evaluation conducted in Section 4.3, the Friable Product Treatment System is recommended as the alternative best able to satisfy the OU-4 closure area WAC in the most efficient, reliable and cost-effective manner. Specifically, this treatment alternative:

- offers the greatest potential for maintaining the overall project schedule (no long-lead equipment procurements; no impacts on the treatability study schedule);
- is the easiest system to operate and maintain (widest operating ranges for process parameters; simplest equipment/control systems);

- offers the greatest operating reliability (simplest operating and maintenance requirements results in lowest downtime probabilities);

- lowest total cost (capital, operating and maintenance, and decontamination and decommissioning).

The Friable Product Treatment System is described in further detail in the following section.

5.0 TREATMENT SYSTEM DESCRIPTION

The waste sludges from the Rocky Flats Solar Evaporation Ponds 207A, 207B, 207C and the 788 Clarifier are currently in interim storage in sixty-six 10,000-gallon, double-contained, high-density polyethylene tanks located in tents on the 750 Pad. These sludges will be removed from the tanks, treated with a pozzolanic agent mix of lime and cement to adsorb free moisture and destroy any pathogens and gas-producing micro-organisms, and mixed with a bulking agent such as sand or other additive to produce a treated waste which satisfies the WAC for the "Contaminated Media" layer of the OU-4 Interim Remedial Action (IRA) closure area (see Section 3.1.1).

The treated waste will be staged in closed containers on the 750 Pad while tests are conducted to confirm compliance with the WAC. Upon satisfying the WAC requirements, the treated waste will be transported to the OU-4 closure area on an as-needed basis for distribution and placement by the closure work area contractor.

The pond sludge (friable product) treatment system, shown on Figure 6, will consist of the following unit operations:

- Transfer of the pond sludges from the interim storage tanks and sludge feed to treatment
- Storage and feeding of treatment additives
- Mixing/blending treatment of pond sludges with additives
- Treated waste storage and testing
- Treated waste transfer to OU-4 closure area

The above operations will be performed with self-contained, skid-mounted, pre-piped, and pre-wired packaged units. Wherever possible, these units will be mobile and will utilize standard "off-the-shelf" equipment. In addition, a number of the equipment modules (tanks, agitators, pumps, etc.) constructed earlier for the Pond A/B and Pond C Cement Stabilization systems will be used where applicable. Standard treatment equipment will be modified, as necessary, to conform to applicable Rocky Flats Plant Health & Safety and Environmental Standards.

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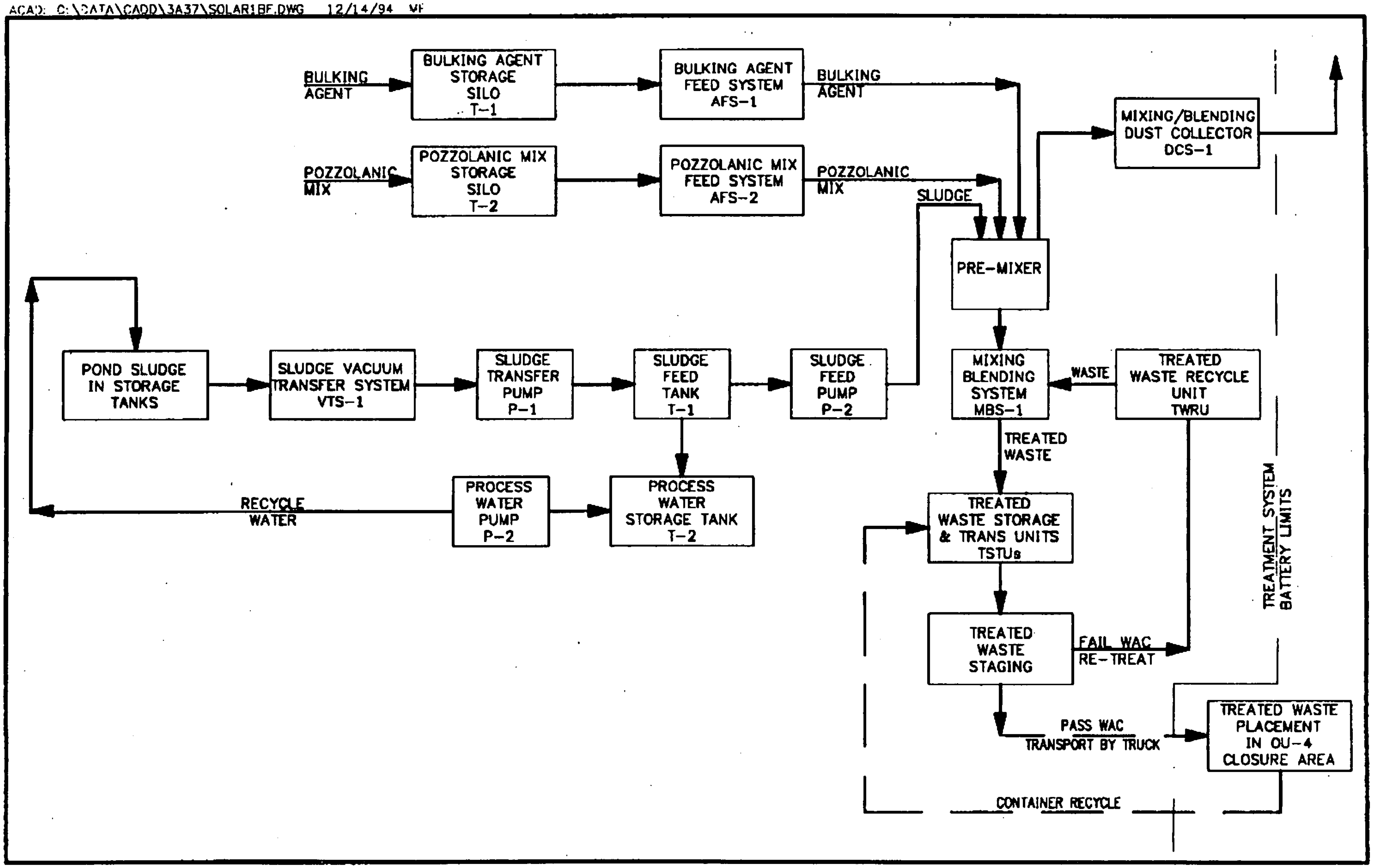

FIGURE 6
CONCEPTUAL BLOCK FLOW DIAGRAM
SOLAR POND SLUDGE TREATMENT SYSTEM
EG&G ROCKY FLATS, GOLDEN, COLORADO

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Containers for the transport of the treated waste will be covered to prevent air emissions and loss of material during transfer to the treatment system. Once the containers have been emptied, they will be returned to their respective unit operations for reuse.

5.1 SLUDGE TRANSFER AND FEED

5.1.1 Operations Description

The sludges from the five Rocky Flats 207 Solar Evaporation Ponds and 788 Clarifier will be removed from the interim storage tanks by one Sludge Transfer Unit (STU) and fed to the treatment process by one Sludge Feed Unit (SFU).

The pond sludges are currently in interim storage in 10,000-gallon capacity, secondarily contained polyethylene tanks located in tents on the 750 Pad. There are approximately 660,000 gallons of sludge in the 66 interim storage tanks.

There are several methods available for removing the sludges from the storage tanks (e.g., semi-portable vacuum system, vacuum truck, submersible slurry pumping, etc.). The STU described below is based on a semi-portable vacuum system because it offers the following advantages:

- It can be located closer to the storage tanks than a vacuum truck,
- It can be emptied and cleaned between batches more easily than a vacuum truck,
- It provides a greater suction head than a vacuum truck,
- It can remove the contents of the tanks more thoroughly than a submersible slurry pump.

The STU consists of a Sludge Vacuum Transfer System (VTS-1), A Sludge Transfer Pump (P-1), and a Sludge Transfer Flow System (FS-1).

The Sludge Vacuum Transfer System includes a vacuum pump and cone-bottom discharge hopper. The vacuum pump will be used to aspirate the pond sludges from the interim storage tanks into the discharge hopper. The suction end of the vacuum hose will be introduced through the manways at the top of the tanks and extended into the sludge. The position of the hose end will be carefully controlled manually to prevent aspiration of air into the suction system. Any liquid which decants from the sludge will be collected and recycled, as necessary, to fluidize the sludge and to rinse the tanks. The discharge hopper will be fully enclosed and will include a venting system equipped with a HEPA filter to treat the pressurized air discharge from the vacuum system.

The sludge collected in the discharge hopper will be transferred to the SFU by a progressive-cavity discharge pump (P-1) and slurry pipeline, which will consist of a high pressure rubber hose system with quick-disconnect fittings to facilitate installation and removal.

The SFU consists of a Sludge Feed Tank (T-1) and Mixer (M-1), a Process Water Storage Tank (T-2), A Sludge Feed Pump (P-2), A Process Water Pump (P-3), and a Sludge Feed Flow System (FS-2). The Sludge Feed Tank is cone-bottomed and will be used to blend and decant the pond sludge prior to treatment. Pond Sludge will be fed from the Sludge Feed Tank to the treatment process by the variable-speed, progressive-cavity, positive-displacement Sludge Feed Pump. Free water decanted in the Sludge Feed Tank and fresh make-up water, if required, will be stored in the Process Water Tank and returned to the STU by the centrifugal Process Water Pump and flexible hoses for sludge dilution and/or tank rinsing.

5.1.2 Operations Control

Removal of the pond sludges from the interim storage tanks with the STU will be a manually-controlled operation. Operational control of the Sludge Vacuum Transfer System will be through a **START-STOP** engine switch and/or an **ON-OFF** electrical push-button located on the STU control panel. The volume of sludge removed will be measured by determining depth of liquid in the discharge hopper. Transfer of the pond sludges from the discharge hopper to the SFU will also be a manually-controlled operation. Operational control of the Sludge Transfer Pump will be through an **ON-OFF** electrical push-button located on the STU control panel. The flow of pond sludges transferred to the SFU will be measured and indicated by the Sludge Transfer Flow System and controlled by manually adjusting the variable speed drive of the Sludge Transfer Pump.

Feed of the pond sludges to the treatment process by the SFU will be a manually-controlled operation. Operational control of the Sludge Feed Tank Mixer, Sludge Feed Pump, and Process Water Pump will be through **ON-OFF** electrical push-buttons located on the SFU control panel. The flow of pond sludges fed to the treatment process will be measured and indicated by the Sludge Feed Flow System and controlled by manually adjusting the variable speed drive of the Sludge Feed Pump.

Grab samples of the removed sludge will be collected at the rate of two samples per interim storage tank. These samples will be field-analyzed for percent moisture content. Results of these field analyses will be used to adjust the feed rate of sludge, and/or the feed rates of additives(s), to the treatment system.

5.2 TREATMENT ADDITIVES STORAGE AND FEED

5.2.1 Operations Description

The treatment additives will be stored and fed by two Additive Storage and Feed Units (ASFUs).

Additives will be used to blend with the pond sludges and produce a friable mix. Although treatability study testing will be required to confirm the nature and quantity of the additives to be used, it is likely that a dry bulking agent such as sand will be added as well as a pozzolanic agent mix of portland cement and lime (hydrated or unhydrated). A bulking agent will be added in sufficient quantity to impart a friable texture to the treated waste. For the purpose of this White Paper, it is assumed that sand will be added as the bulking agent in a sand-to-sludge ratio of 2.5:1 by volume. The cement and lime mix will be added in quantities sufficient to complete the adsorption of free moisture and achieve a pH of approximately 12 in the treated waste to destroy any pathogens and gas-producing micro-organisms that may be present in the sludge. For the purpose of this White Paper, it is assumed that Portland Type II cement and hydrated lime [$Ca(OH)_2$] will be used, at the rate of about 0.5 tons of cement/lime mix per wet ton of Ponds 207 A and B sludge, and at the rate of about 260 pounds of cement/lime mix per dry ton of Pond 207C sludge.

Additives such as drying agents (e.g., calcium chloride, silica gel, etc.) or other pozzolanic agents, such as fly ash, and/or bulking agents, such as bentonite, may be required, pending the results of treatability testing.

Each ASFU will consist of a Storage Silo (T-3 for bulking agent, T-4 for pozzolanic agent) and an Additive Feed System (ASF-1 for bulking agent, ASF-2 for pozzolanic agent).

The treatment additives will be delivered to the treatment site by bulk hopper truck and stored in the Storage Silos. The transfer from the hopper truck to the Storage Silo will be performed by a standard commercial pneumatic transport and delivery system which is part of the bulk hopper truck unloading system. The Storage Silos will be equipped with a passive venting and dust collection system which will control any emissions during delivery or operations.

The additives will be fed to the treatment process by the Additive Feed Systems. Each Additive Feed System will consist of a rotary valve feeder, a weigh-belt conveyor, and a screw conveyor. The additive will be discharged onto the weigh-belt conveyor by the rotary valve feeder and the weigh-belt feeder will measure and control the delivery rate of the rotary valve feeder. The controlled amount of additive will then be delivered to the feed point of the treatment process by the screw conveyor.

5.2.2 Operations Control

Transfer of the treatment additives from the bulk delivery truck to the Storage Silo will be a manually-controlled operation. The truck-mounted transfer air blower will be operated by the truck driver.

The amount of additive in the Storage Silo will be measured and indicated by level-sensing devices. High- and low-level conditions inside the Storage Silo will be alarmed.

Operation of the Additive Feed Systems will be a manually-initiated and semi-automatically-controlled operation. The rotary valve feeder, weigh-belt conveyor, and screw conveyor will be manually started and stopped by **ON-OFF** electrical push-buttons located on the ASFUs control panels. Additive feed rate will be automatically controlled to a manually-set rate by the weigh-belt conveyor which will regulate the operational speed of the rotary valve feeder and screw conveyor.

5.3 MIXING/BLENDING TREATMENT

5.3.1 Operations Description

The mixing/blending treatment of pond sludges with additives is performed in one Mixing Treatment Unit (MTU).

The treatment process consists of mixing/blending the pond sludges with the treatment additives (sand and cement/lime mix) as necessary to produce a treated waste that satisfies the WAC.

The MTU consists of a Mixing/Blending System (MBS-1), a Treated Waste Container Jockey System (JS-1), and a Mixing/Blending Dust Collector (DCS-1).

The Mixing/Blending System includes a pre-mixer, a twin-shaft pug-mill, and a covered belt-type conveyor with shrouded discharge chute. The solar pond sludge is first blended in the pre-mixer with the pozzolanic agent mix to maximize cement and lime hydration. The combined solar pond sludge and pozzolanic agent mix is then blended with the bulking agent in the pug mill. The treated waste is transferred from the pug mill to a roll-off-type container by the belt conveyor and discharge chute.

The bulking agent adsorbs a portion of the free moisture contained in the pond sludge and increases its cohesiveness. The pozzolanic agent mix binds the pond sludge particles and absorbs any residual free moisture in addition to serving as a biocide. The character of the treated waste is presumed to be similar to a friable soil. It will have no free moisture (estimated maximum moisture content of 20 percent by weight) and should be dust free (estimated minimum moisture content of 15 percent by weight).

The Treated Waste Container Jockey System slowly moves the treated waste container along a short length of track with a winch and pulley system to evenly distribute the treated waste inside the container.

Dust generated by the operation of the Mixing/Blending System will be collected by the Mixing/Blending Dust Collector System. This system consists of a baghouse-type collector, an exhaust blower, and an exhaust HEPA filter. Dust emissions are aspirated through the baghouse collector by the exhaust blower. The baghouse collector removes the majority of the dust contained in the exhaust airstream and any residual dust is removed from the discharge of the exhaust blower by the HEPA filter. Excess dust accumulated in the baghouse collector is periodically removed for re-processing through the treatment system.

5.3.2 Operations Control

The treatment of the pond sludges by mixing/blending with additives will be a manually-controlled operation. Operational control of the Mixing/Blending System equipment will be through **ON-OFF** electrical switches mounted on the MTU control panel. The rate of production of treated waste will be controlled by the operational speed of the pug mill and belt conveyor and by the feed rates of the sludges and treatment additives, which will be based on the free moisture content of the sludge and on the treatment parameters developed from the treatability test results. The operational speed of the pug-mill and belt conveyor will be manually adjusted by the variable-speed controls located on the MTU control panel.

Operational control of the Treated Waste Container Jockey System will be through **ON-OFF** electrical push-buttons located on the MTU control panel.

Operational control of the Mixing/Blending Dust Collector will be through **ON-OFF** electrical push-buttons located on the MTU control panel.

5.4 TREATED WASTE STORAGE AND TESTING

5.4.1 Operations Description

The treated waste is stored and tested in eight Treated Waste Storage and Transport Units (TSTUs).

The treated waste is discharged from the Mixing/Blending System belt conveyor directly into one of the TSTUs. Each TSTU consists of a roll-off type container equipped with a removable top cover, an end-dump gate, and bottom wheels for movement on the tracks of the MTU's Treated Waste Container Jockey System. When filled, the top cover is placed on the TSTU and it is moved away from the loading point to permit introduction of an empty TSTU. The full TSTUs will be moved to an area of the 750 Pad, or other suitable location, to be staged/stored for curing purposes. Staging of treated waste will also provide a surge or buffer capacity between the operating requirements and schedule of the treatment system and those of the closure area contractor. Eight TSTUs of treated waste will be staged representing about two days production of the MTU.

Routine testing of the staged treated waste will be performed as discussed in Section 5.4.2. In the unlikely event that the contents of a TSTU does not satisfy the WAC, re-treatment will be required. Non-attainment of the WAC may result from changes in the pond sludges. Typically, it is expected that the treatment mix formulation will be effective over a wide range of operating conditions and pond sludge composition.

In the event that the contents of a TSTU fails to meet the WAC, the off-specification treated waste will be removed from the TSTU and returned to the MTU's Mixing/Blending System by a Treated Waste Recycle Unit (TWRU) featuring a portable vacuum system similar to that used as part of the STU for removal of the pond sludges from the interim storage tank (see Section 4.1). In the MTU's Mixing/Blending System, the off-specification treated waste will be mixed with extra bulking agent and/or pozzolanic agent mix to meet the WAC.

5.4.2 Operations Control

Transfer, storage, and testing of treated waste in the TSTUs will be a manually-controlled operation.

Operational control of the treated waste transfer and storager will be performed by regulating the traffic of TSTU tractor trucks between the MTU, the treated waste staging/storage area, and the OU-4 disposal area.

Grab samples of treated waste will be collected from the TSTUs at the staging/storage area after completion of the curing period. The treated waste samples will be field-tested for compliance with the WAC. In particular, these field tests will verify that the treated waste samples pass the Paint Filter Liquids Test (SW 9095) and that the pH of the treated waste is at least equal to the value determined from the treatability study as necessary for the destruction of pathogens and gas-producing micro-organisms.

5.5 TREATED WASTE TRANSFER TO OU-4

5.5.1 Operations Description

The treated waste will be transferred to the OU-4 closure area in the same TSTUs as used for staging and storage. Once the treated waste has been removed from the TSTUs at the OU-4 closure area, the empty TSTUs will be returned to the MTU to receive additional treated waste.

5.5.2 Operations Control

Transportation of the treated waste to the OU-4 placement area will be controlled by regulating the traffic of TSTU tractor trucks between the treated waste staging/storage area and the OU-4 placement area.

5.6 DECONTAMINATION AND DECOMMISSIONING

5.6.1 Description

Upon completion of solar pond sludge treatment activities, the removal and treatment equipment will be decontaminated and decommissioned.

Decontamination will consist of thoroughly flushing and rinsing with fresh service water all vacuum units, pumps, mixers, tanks, hoppers, containers, and piping which came into contact with the pond sludge, the treatment additives, and the treated waste to completely remove these materials from the equipment. As required, the decontamination process may also involve the use of low-pressure steam or mechanical scrubbing with detergent-type products or other solvents. Waste decontamination fluids will be transferred to the Building 374 Spray Dryer for disposal.

Decommissioning will consist of dismantling the sludge removal and treatment system to the extent that it will not be possible to re-activate this system on an instantaneous, or near-instantaneous basis. To this effect, flexible piping and hoses will be removed, hard-piped connections will be broken, blind flanges will be installed, and operating valves will be removed. Electrical supply to control panels and switches will be disconnected and strategic wiring removed. Additive storage silos will be emptied and the additives stockpiled at a remote location or used elsewhere in the Rocky Flats Plant.

5.6.2 Process and Operational Controls

The decontamination and decommissioning of the sludge removal and treatment system will be a strictly manual operation.

The effectiveness of the decontamination process will be verified by the collection and analysis of wipe samples from the decontaminated equipment to verify that all waste and additives have been adequately removed.

6.0 SCHEDULE

Based on the information generated in this White Paper the following estimated project schedule for the Solar Pond Sludge Treatment System Project was developed:

• Complete Conceptual Design Report	May 19, 1995
• Begin Title II Design	June 5, 1995
• Complete Title II Design	October 6, 1995
• Begin Procurement/Installation	November 6, 1995
• Complete Procurement/Installation	March 29, 1996
• Begin Commissioning/Training	April 1, 1996
• Complete Commissioning/Training	April 29, 1996
• Begin Treatment Operations	May 27, 1996
• Complete Treatment Operations	November 29, 1996
• Begin Decontamination and Dismantling	December 2, 1996
• Complete Decontamination and Dismantling	December 31, 1996
• Schedule Reserve	January 3, 1997 to April 20, 1997

The treatment operations schedule is based on the information provided in Table 1, Section 3.1.3.

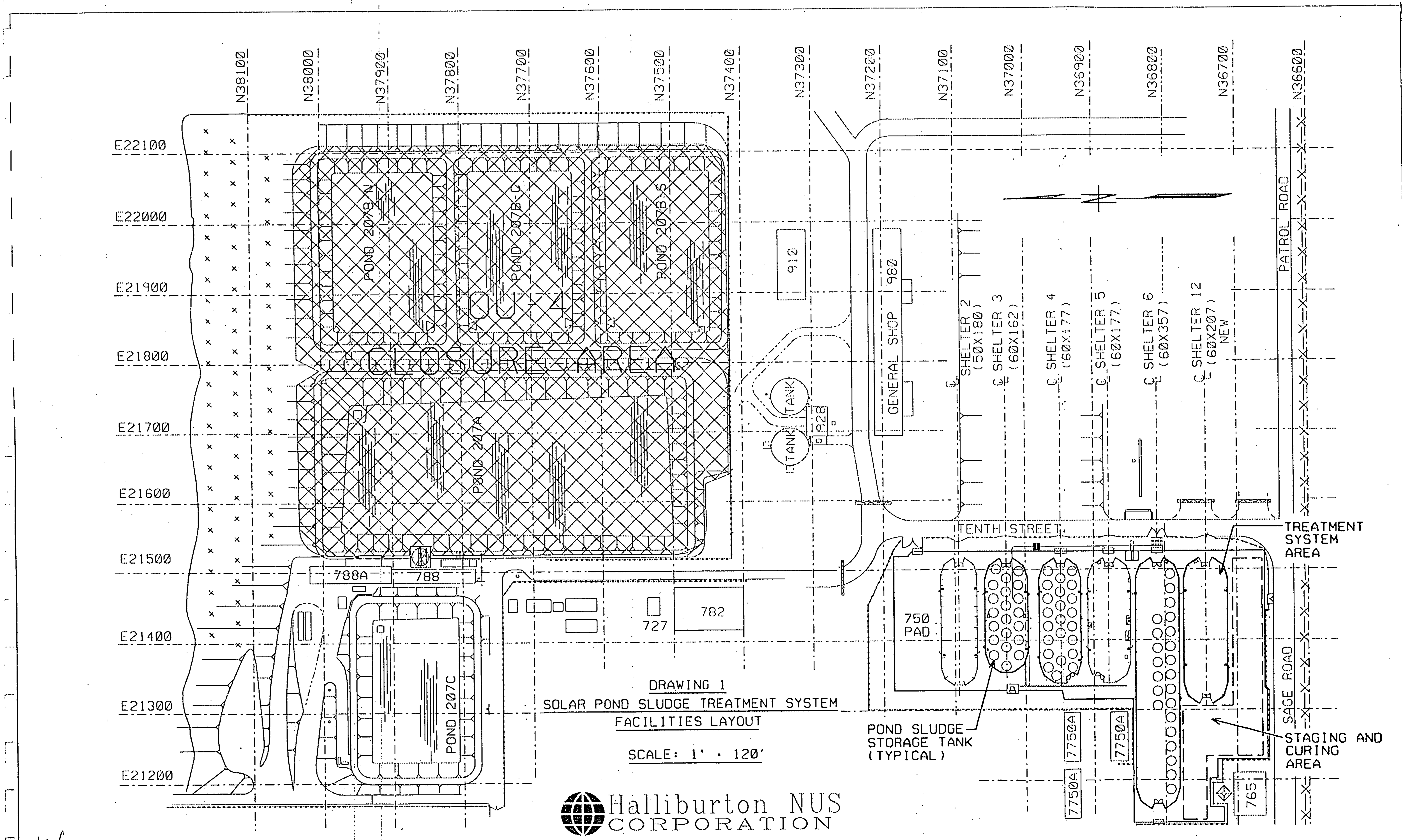
This schedule assumes that the review periods that occur between the various project tasks will proceed in a timely manner.

7.0 COST ESTIMATES

The following preliminary cost estimates are based on the solar pond sludge treatment system described in Section 5 of this White Paper:

Procurement and Installation (Capital Cost)	$2,200,000
Operations and Maintenance Costs	$2,700,000
Decontamination and Dismantling Costs	$ 170,000

The operations and maintenance costs are based on operating 16 hours/day, 5 days/week for 10 months.



DRAWING 1
SOLAR POND SLUDGE TREATMENT SYSTEM
FACILITIES LAYOUT

SCALE: 1' · 120'

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